The XMM-Newton Bright Serendipitous Source Sample

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ON THE BEHALF OF THE XMM-NEWTON SURVEY SCIENCE CENTRE (SSC) CONSORTIUM [a]

We summarize here the current status of the XMM BSS: a large ($\sim$ 1000 sources) sample of bright serendipitous XMM sources at high galactic latitude ($|b| > 20$ deg).

1 Introduction

Deep *Chandra* and *XMM–Newton* observations (Brandt et al. 2001; Rosati et al. 2002; Moretti et al., 2002; Hasinger et al., 2001) have recently resolved $>\sim$ 80% of the 2–10 keV X-ray background (XRB) into discrete sources down to $f_x \sim 3{\times}10^{-16}$ erg cm^{-2} s^{-1}. The statistical analysis (stacked spectra and hardness ratios) performed on these samples provided an indication of the X–ray spectral properties of the sources making up most of the XRB. The X–ray data are consistent with AGN being the dominant population of the XRB and, as inferred by the X–ray colors, a significant fraction of these sources have hard, presumably obscured, X–ray spectra, in agreement with the predictions of XRB synthesis models (see Madau et al., 1994; Comastri et al., 1995; Gilli et al. 2001). However the majority of the sources found in these medium-deep fields are too faint to provide good X–ray spectral information. Moreover, the extremely faint magnitude of a large part of their optical counterparts makes the spectroscopic identifications very difficult, or even impossible, with the exisisting ground–based optical telescopes. Thus, notwithstanding the remarkable results obtained by reaching very faint X–ray fluxes, the broad–band physical properties (e.g. the relationship between optical absorption and X-ray obscuration and the reason why AGN with similar X-ray properties have completely different optical appearance) are not yet completely understood. A step forward toward the solutions of these issues has been recently obtained by

[a]The SSC is an international collaboration involving a consortium of several institutions, appointed by ESA, to exploit the XMM-Newton serendipitous detections for the benefit of the international scientific community (see Watson et al., 2001 and http://xmmssc-www.star.le.ac.uk for a full description of the program).

Mainieri et al., 2002 and Piconcelli et al., 2002 using a small sample of serendipitous sources for which medium-good quality XMM-Newton and optical data are available.

With the aim of complementing the results obtained by medium-deep X-ray surveys, the XMM-Newton Survey Science Centre (SSC) is building up the **"The XMM-Newton Bright Serendipitous Source Sample"** (XMM BSS, Della Ceca et al. 2002): a large ($\sim$ 1000 sources) sample of bright ($f_x \geq\sim 10^{-13}$ erg cm^{-2} s^{-1}) serendipitous XMM sources at high galactic latitude ($|b| > 20^o$). The well defined criteria (completeness, representativeness, etc..) of this sample will allow both a detailed study of sources of high individual interest and statistical population studies. In particular, the XMM BSS **will be fundamental to complement other medium and deep XMM and *Chandra* survey programs (having fluxes 10 to 100 times fainter and covering a smaller area of the sky) and will provide a larger baseline for all evolutionary studies.** Moreover, the high X–ray statistics which characterize most of the sources in the XMM BSS sample, combined with the relative brightness of their optical counterparts, allow us to investigate in detail their physical properties.

The XMM BSS Sample

The XMM BSS is part of the follow-up program being conducted by the XMM-Newton Survey Science Center. The XMM BSS is lead by the *Osservatorio Astronomico di Brera* (Milan, Italy) and consists of two flux-limited samples having flux limits of $\sim 10^{-13}$ erg cm^{-2} s^{-1} in the 0.5–4.5 keV (XMM BSS "soft" sample) and in the 4.5-7.5 keV (XMM BSS "hard" sample) energy band.

As of today, 195 suitable XMM-Newton fields have been analyzed and a first sample of 331 sources selected: 321 sources belongs to the "soft" sample and 64 sources to the "hard" sample with 54 sources in common. The optical counterpart of the majority (85-90%) of these X-ray sources has an optical magnitude above the POSS II limit (R $\sim 21^{mag}$), thus allowing spectroscopic identification on a 4 meter telescope. It is worth noting that, given the accuracy of the X-ray positions (2-5 arcsec at the 90% confidence level) and the magnitude of the expected optical counterpart, only one object needs to be observed to obtain the optical identification. For this reason the complete spectroscopic identification of the two samples is feasible with a reasonable number of telescope nights. Up to now 177 sources have been spectroscopically identified (either from the literature or from our own observations at ESO, TNG and Calar Alto telescopes) leading to a 54% and 73% identification rate for the "soft" and "hard" samples respectively. The optical breakdown of the XMM

BSS sources identified so far is reported in Table 1.

Table 1: The current optical breakdown of the XMM BSS Sample

	"Soft" Sample $S_{0.5-4.5keV} \geq 7 \times 10^{-14}$ cgs	"Hard" Sample $S_{4.5-7.5keV} \geq 1 \times 10^{-13}$ cgs
Objects[1]	321	64
Identified:	172	47
AGN-1	113	26
AGN-2	19	15
Clusters of Galaxies	3	1
Galaxies	6	3
BL Lacs	2	0
Stars	29	2

[1] Note that 54 sources are in common between the "soft" and "hard" sample.

The hardness ratio distribution

A "complete" spectral analysis for all the sources in the XMM BSS is in progress; in the meantime a "snapshot" of the X-ray spectral properties of the identified sources obtained using the "hardness ratio" method (equivalent to the "color-color" analysis largely used at optical wavelengths) is shown in figure 1. A fairly sharp separation between Galactic and extragalactic sources is visible in figure 1 (left panel): 25 out of 29 stars have HR2<–0.7. Moreover it is worth noting that both in the hard and in the soft samples Broad Line AGNs lie in the range -0.8<HR2<–0.3 (except for a few cases). On the contrary Narrow Line AGNs are distributed over a larger area in the "hardness ratio" plot with the trend to have a larger HR2 value for the Narrow Line AGNs belonging to the XMM BSS "hard" sample. Besides the theoretical implications of this segregation, the sensitivity of the HR2 value to the optical spectral type of the X-ray sources can offer a powerful tool to increase the efficiency for the selection of rare and interesting classes of objects (e.g. the absorbed AGNs). Preliminary results for a first sample of "XMM BSS optically dull" galaxies are discussed in Severgnini et al., (this conference).

Acknowledgments

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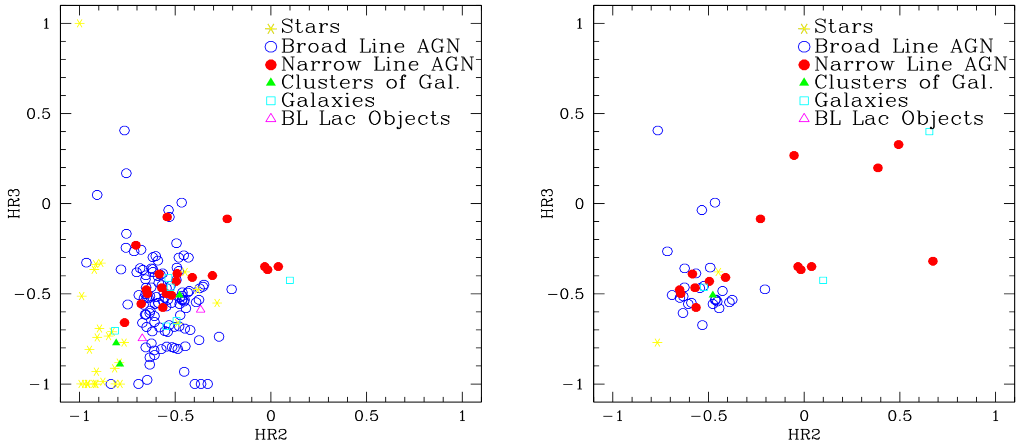

Figure 1: HR2 vs. HR3 for the identified objects belonging to the XMM BSS "soft" sample (left panel) and to the XMM BSS "hard" sample (right panel). HR2 and HR3 for each source have been computed using the source count rate in the (0.5−2 keV), (2−4.5 keV) and (4.5−7.5 keV) energy band according to: $HR2 = [C(2-4.5) - C(0.5-2)]/[C(2-4.5) + C(0.5-2)]$ and $HR3 = [C(4.5-7.5) - C(2-4.5)]/[C(4.5-7.5) + C(2-4.5)]$. We have used different colors to mark the identified objects and, for clarity, we have not reported error bars.

References

1. W.N. Brandt *et al*, ApJ **122**, 2810 (2001).
2. A. Comastri *et al*, A&A **296**, 1 (1995).
3. R. Della Ceca *et al*, in "New Visions of the X-ray Universe in the XMM-Newton and Chandra Era" **SP-488, Eds. F.Jansen**, astro-ph/0202150 (2002).
4. R. Giacconi *et al.*, ApJS **139**, 369 (2002).
5. R. Gilli *et al.*, A&A **366**, 407 (2001).
6. G. Hasinger *et al.*, A&A **365**, L45 (2001).
7. P. Madau *et al.*, MNRAS **270**, L17 (1994).
8. V. Mainieri *et al.*, A&A **393**, 425 (2002).
9. A. Moretti *et al.*, ApJ **570**, 502 (2002).
10. E. Piconcelli *et al.*, A&A **in press**, astro-ph/0208183 (2002).
11. P. Rosati *et al.*, ApJ **566**, 667 (2002).
12. M. G. Watson *et al.* A&A **365**, L51 (2001).